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DRAWINGS ATTACHED

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(54) AGITATING APPARATUS

(71) We, KYOWA HAKKO KOGYO CO. LTD., a corporation organised under the laws of Japan, of 4, Ohtemachi-1-chome, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an agitating assembly which is adapted for use in an aeration agitating tank containing a reaction liquid or a fermentation medium. More particularly, the present invention is directed to an agitating apparatus which provides good gas-liquid phase contacted for conducting various types of reactions including fermentation processes.

In a gas-liquid reaction type apparatus where a gas is blown into a liquid phase or in an apparatus which is used for culturing submerged aerobic microorganisms, various types of agitating blade assemblies such as impellers having about 4 to 6 flat blades, impellers having curved blades, disc impellers having bottom blades which are situated in the bottom part of the tank have been employed. Heretofore fixed guide blades have been used to improve contact of gas with the liquid but such use does not sufficiently disperse the gas into the liquid and accelerate the rate of transfer of the gas into the liquid. When agitation is conducted with a flat blade impeller and a curved blade impeller but without the use of bottom blades it is necessary to conduct agitation using a large number of revolutions to obtain a sufficient contact of the gas and liquid phases, and the necessary rate of gas dissolution while providing uniformity of the liquid in the tank. Thus when utilising said impellers without bottom blades the power consumption which is required is much greater

A gas absorber is known which provides gas-liquid phase contact using a fixed guide blade assembly in a liquid-gas phase agitation system. However, in this case, the blade wheel is provided at a relatively high position in the tank, that is at a level in the middle of the liquid depth or even higher. Since the guide blade assembly is of the top-covered guide blade type, the liquid discharged from the blade wheel contains a large amount of bubbles, a substantial portion of which move upwards in direction while the gas discharged from the blade wheel travels towards and hits the tank wall. Consequently, the bubbles are not distributed in the liquid at the bottom portion of the tank. Thus, the necessary rate of gas dissolution cannot be obtained with a small number of revolutions and with a small amount of power consumption. Under these circumstances, it has been necessary to develop a fixed guide blade assembly that allows a bubble-containing liquid discharged from a blade wheel to traverse the entire tank and provide a uniformity and evenness throughout the entire tank while developing a vigorous shearing force between the guide blades and the blade wheel to promote dissolution of the gas in the liquid phase.

According to the invention we provide an agitating assembly comprising a stationary guide plate provided with a centrally disposed opening, the outer, peripheral portion of said guide plate being canted upwardly and provided with radially extending guide blades disposed on the upper side thereof, means for supporting the guide plate, a blade wheel disposed immediately above the guide plate and being rotatable with respect thereto, an agitating shaft secured to the blade wheel and means to rotate said shaft and said blade wheel. The guide blades disposed on the peripheral portion of the guide plate may conveniently be curved. Furthermore the height of the guide blades may be gradually reduced in the direction of the periphery of the guide plate.

An embodiment of the invention will now be described with reference to the accompanying drawing in which:—

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Figure 1 shows an agitating apparatus of the present invention including an agitating tank;

Figure 2 is a schematic view of the bottom-covered guide blade assembly of Figure 1;

Figure 3 is a plan view of the guide blade assembly of Figure 2; and

Figure 4 is a cross sectional view of Figure 3 taken along the line A—A¹.

Referring now to the drawings wherein like reference numerals are used throughout the various views to designate like parts, the apparatus of the present invention comprises an aeration agitating tank 4 containing an agitating assembly comprising a bottom-covered guide blade assembly 1 and a blade wheel 3 disposed in the lower portion of the agitating tank. Said tank contains a reaction medium, for example a fermentation medium 9, disposed therein. The blade wheel 3 is rotated by an agitating shaft 7 supported by a bearing 8. Injection nozzles 5 are provided in the lower portion of the tank and function to inject a gas to the bottom side of the bottom-covered guide blade assembly 1. The injection nozzles 5 are in communication with a aeration pipe 6 which functions to introduce the gas to the injection nozzles. The bottom-covered guide blade assembly 1 is fixed to the bottom of the aeration agitating tank 4 outside the blade wheel 3 by means of supports 2. Inlet 10 provides a means for introducing the reaction liquid or the fermentation medium 9 into the reaction vessel, element 11 is a vent for removing the unabsorbed, unreacted gas, and 12 is an outlet for removing the reaction liquid or the fermentation medium from the tank.

Details of the bottom-covered guide blade assembly are shown in Figures 2, 3 and 4 wherein numeral 13 is a bottom-covering guide plate, 14 represents an upwardly canted peripheral portion of the guide plate and element 15 represents radial guide blades. The bottom-covered guide blade assembly is fixed to supports 2 by means of collars 16 for making the guide blade assembly stationary. Gas injected from the injection nozzles 5 passes upwards through a centrally disposed opning in the bottom-covering guide plate 13 of the bottom-covered guide blade assembly 1, and is agitated by the blade wheel 3. The bubbles created thereby are made finer by the vigorous shearing force developed between the blade wheel 3 and the stationary bottom-covering guide plate 13, whereby the gas is dissolved. The liquid containing the finer bubbles thus obtained is directed upwards by the upwardly extending portion of the guide plate 14, thereby creating a vertical circulating flow which extends through the entire tank. The liquid discharged from the blade wheel is directed in the radial direction by radial guide blades 15 and said liquid moves upwards along the tank wall to obtain uniformity and evenness throughout the tank.

Table 1 shows the results obtained by measuring the sodium sulfite oxidation rate by charging 40 l. of a sodium sulfite solution into a 60 liter aeration agitation tank of 350 mm inner diameter and passing 25 l. per minute of air therethrough. Table 2 shows values of power required for agitation, said values, being obtained by charging the same liquid in the same aeration agitating tank and using a strain gauge.

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TABLE 1

Sodium Sulfite Oxidation Rate

Kg a (kg-mol/m³, hr.atm)

Type of blade wheel and guide blade assembly \ Number of revolution (r.p.m.)	300	500	700
Bottom blade disk impeller	1.185×10^{-1}	4.25×10^{-1}	6.75×10^{-1}
Bottom blade disk impeller with bottom-covered guide blade assembly	1.570×10^{-1}	5.00×10^{-1}	8.90×10^{-1}
Flat blade impeller (6 blades)	1.310×10^{-1}	4.63×10^{-1}	9.70×10^{-1}
Flat blade impeller (6 blades) with bottom-covered guide blade assembly	2.01×10^{-1}	7.65×10^{-1}	1.450
Gas absorber type	5.60×10^{-2}	1.360×10^{-1}	4.18×10^{-1}
Gas absorber type, whose guide blades are replaced with bottom-covered guide blade assembly	9.15×10^{-2}	2.75×10^{-1}	7.15×10^{-1}

TABLE 2

Power Consumed for Agitation
— (Kg. m/s)

Type of blade wheel and guide blade assembly \ Number of revolution (r.p.m.)	300	500	700
Bottom blade disk impeller	0.65	2.95	10.74
Bottom blade disk impeller with bottom-covered guid blade assembly	0.67	3.02	10.50
Flat blade impeller (6 blades)	3.25	8.48	18.56
Flat blade impeller (6 blades) with bottom-covered guide blade	3.20	8.45	19.02
Gas absorber type	0.563	2.28	8.10
Gas absorber type, whose guide blades are replaced with bottom-covered guide blade assembly	0.345	2.16	7.53

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As shown in Tables 1 and 2, the power consumption is not changed very much at the same number of revolutions in the case of the bottom blade disk impeller and flat blade impeller (6 blades), between that provided with a bottom-covered guide blade assembly and that not provided with said assembly, but the sodium sulfite oxidation rate becomes about 1.3 to about 1.6 times higher. When the guide blade assembly used in the gas absorber is replaced with a bottom-covered guide blade assembly and the latter is provided at the bottom of the tank as shown in Figure 1, the power consumed for agitation is reduced by about 60% to 90%, as shown in Figure 2, but the sodium sulfite oxidation rate becomes about 1.6 to 2 times higher.

WHAT WE CLAIM IS:—

1. An agitating assembly comprising a stationary guide plate provided with a centrally disposed opening, the outer peripheral portion of said guide plate being canted upwardly and provided with radially extending guide blades disposed on the upper side thereof, means for supporting the guide plate, a blade wheel disposed immediately above the guide plate and being rotatable with respect thereto, an agitating shaft secured to the blade wheel and means to rotate said shaft and said blade wheel.

2. The agitating assembly of claim 1, wherein the guide blades disposed on the peripheral portion of the guide plate are curved.

3. The agitating assembly of claim 2, wherein the height of the guide blades is gradually reduced in the direction of the periphery of the guide plate.

4. An agitating apparatus as claimed in any of claims 1 to 3, situated in a tank having an inlet for introducing the material to be treated thereto, an outlet for removing treated material therefrom and means for introducing a gaseous medium into the tank below the guide plate, the guide plate being situated in the lower portion of the tank.

5. The apparatus of claim 4, wherein the means for introducing the gaseous medium is an injection nozzle.

6. The apparatus of claim 5, wherein an aeration pipe communicates with said injection nozzle.

7. The apparatus of any of claims 4 to 6, wherein the agitating shaft extends through the centrally disposed opening in the guide plate and terminates in a bearing supported in the lower portion of the tank.

8. The apparatus of any of claims 4 to 7, wherein the tank is provided with a vent.

9. The apparatus of any of claims 4 to 8, wherein the peripheral portion of the guide plate is provided with at least one collar for receiving a support fixed to the bottom of the tank.

10. Agitating assembly substantially as hereinbefore described and illustrated in the accompanying drawings.

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Sheet 1

FIG. 1

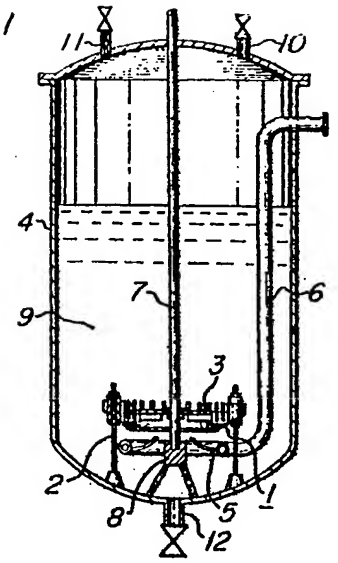
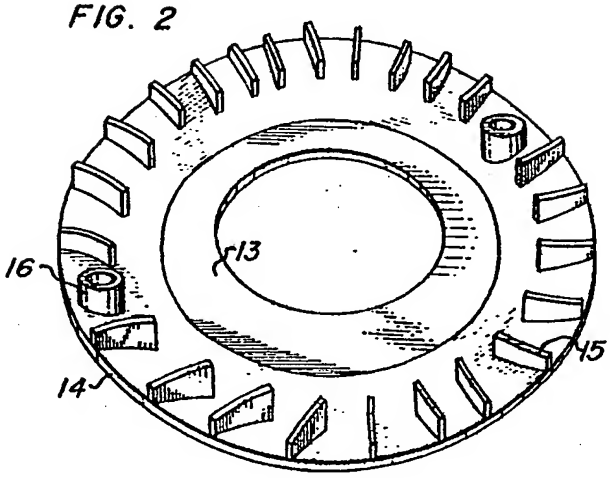


FIG. 2



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Sheet 2

FIG. 3

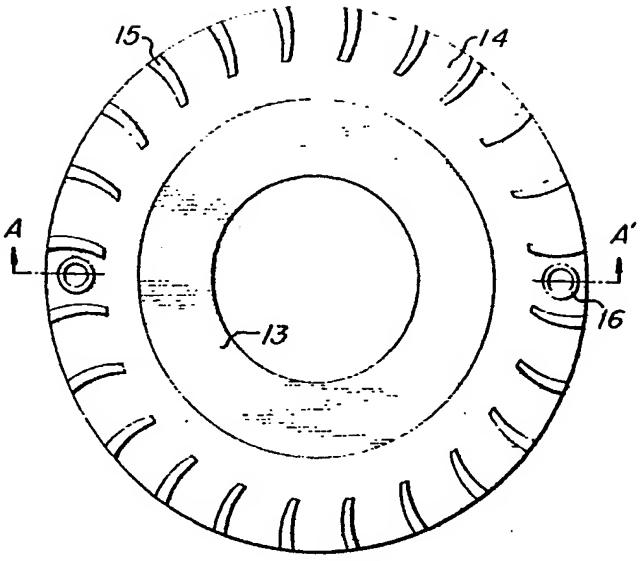

FIG. 4